

STRENGTH OF MATERIALS

Beam Deflections

Objective

The purpose of this exercise is to determine theoretically the elastic curve for a loaded beam, and to compare the theoretical results with numerical results and with experimental measurements of deflection.

Procedure

The apparatus for this exercise is several different beams and loading combinations, a dial indicator, stand, and extension arm. Extreme caution must be exercised when using this delicate instrument. With a little care, very accurate results may be obtained with this apparatus. One or more of the problems on the following pages will be assigned by your instructor.

Solve for the following quantities:

1. The shear and bending moment diagrams.
2. The magnitude and location of the maximum bending stress and the maximum shear stress.
3. The equation of the elastic curve.
4. The point of the maximum deflection and its value.

Measure the beam deflections under load at several locations along the beam. Since the beam is initially not perfectly straight, you must completely unload the beam, move and re-zero the dial indicator, and then reload for each measurement. Run your problem or problems using the MDSolids program. Print out the tabulated deflection results from MDSolids to compare with the results of your analysis and the experimental measurements.

Report

The laboratory report should be in the format requested by your instructor and contain the following for each beam analyzed:

1. Hand calculations showing all results requested under procedure above.
2. Tabulated results showing the measured deflections along the beam.
3. Output showing the results of an MDSolids analysis
4. A QUATTRO or EXCEL plot comparing theoretical, experimental, and MDSolids deflections along the beam.
5. A discussion of the observed differences in the theoretical, numerical, and experimental results.

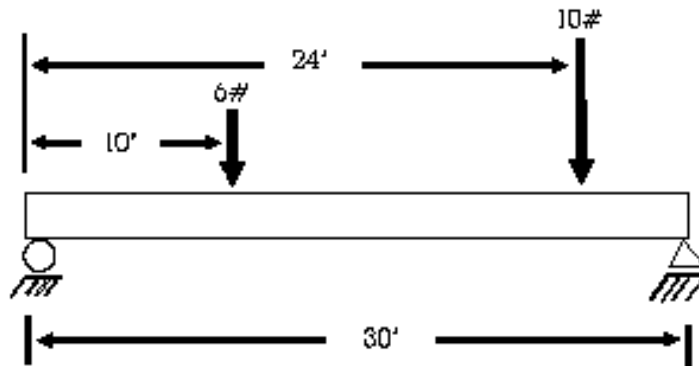
Problem 1

Using Apparatus 1 investigate the deflections along a simply supported beam under the action of a concentrated load of 6 lbs placed on the beam at a distance of $x = 10$ inches and a concentrated load of 10 lbs at $x = 24$ inches. The distance between supports is 30 inches. Orient the beam to produce maximum deflection. Verify the theoretical deflection equation.

The following equipment is available:

- Roller support
- Angle support
- Aluminum WF beam ($E = 9.5 \times 10^6$ psi, $I = 0.0210 \text{ in}^4$, $S = 0.042 \text{ in}^3$)
- Dial indicator
- Ruler
- 1 - 6 lb weight
- 1 - 10 lb weight

Return all equipment to its assigned location after use.



Apparatus 1

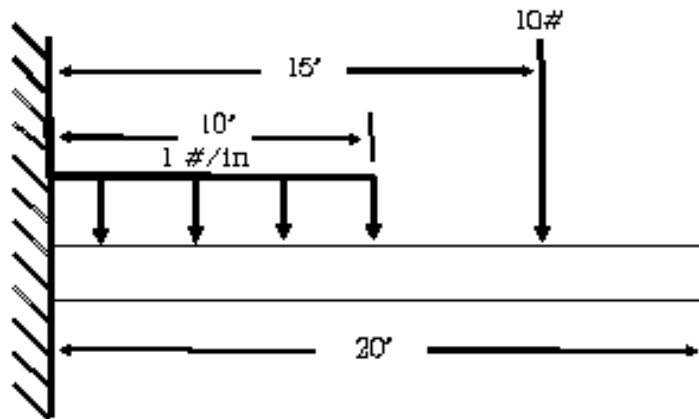
Problem 2

Using Apparatus 2 investigate the deflection along an aluminum cantilever beam under the action of a uniformly distributed load placed of 1 lb/in on the beam at a distance of $x = 0$ to $x = 10$ in. and a concentrated load of 10 lbs at $x = 15$ in. Orient the beam so as to give minimum deflection under the given loads. Verify the theoretical equation at several locations along this beam.

The following equipment is available:

- Beam support
- Dial indicator
- Aluminum WF beam ($E = 9.5 \times 10^6$ psi, $I = 0.0525 \text{ in}^4$, $S = 0.105 \text{ in}^3$)
- 10 - 1 lb weight
- 1 - 10 lb weight
- Ruler

Return all equipment to its assigned location after use.



Apparatus 2

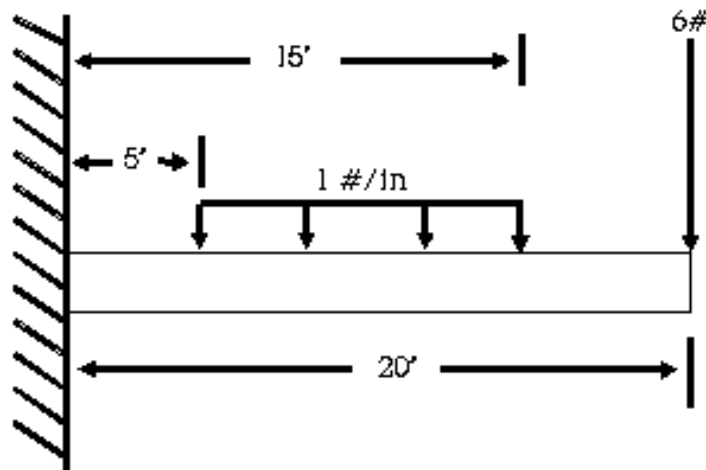
Problem 3

Using Apparatus 3 investigate the deflection of an aluminum cantilever beam under the action of a uniformly distributed load of 1 lb/in placed at a distance of $x = 5$ in. to $x = 15$ in. and a concentrated load of 6 lbs placed at $x = 20$ in. Orient the beam to give minimum deflection. Verify the theoretical deflection equation at several locations along this beam.

The following equipment is available:

- Beam support
- Dial indicator
- A box aluminum beam with end plug ($E = 10 \times 10^6$ psi, $I = 0.0329$ in⁴, $S = 0.0658$ in³)
- 1 - 6 lb weight
- 10 - 1 lb weights
- Ruler

Return all equipment to its assigned location after use.



Apparatus 3

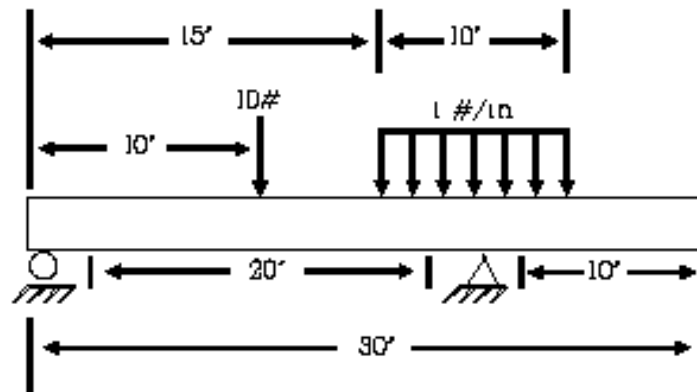
Problem 4

Using Apparatus 4 investigate the deflection along an overhanging beam with 20 in. between supports and with a 10 in. overhang on one end. The beam will be loaded with a uniformly distributed load of 1 lb/in from $x = 15$ in. to $x = 25$ in. and a 10 lb concentrated load at $x = 10$ in. Orient the beam to produce maximum deflection. Verify the theoretical deflection equation at several sections along the beam. Place the overhang portion to the right.

The following equipment is available:

- Beam support
- 1 Roller support
- 1 Angle support
- A box aluminum beam ($E = 10 \times 10^6$ psi, $I = 0.0095 \text{ in}^4$, $S = 0.038 \text{ in}^3$)
- Dial indicator
- 1 - 10 lb weight
- 10 - 1 lb weights
- Ruler

Return all equipment to its assigned location after use.



Apparatus 4

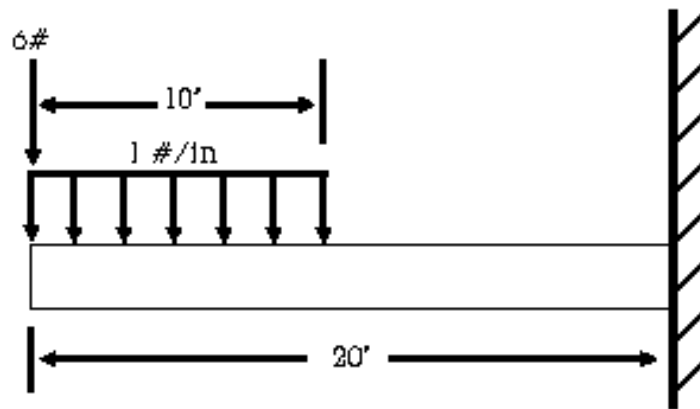
Problem 5

Using Apparatus 5 investigate the deflection of a brass cantilever beam 20 in. in length. A uniformly distributed load of 1 lb/in is placed at a distance of $x = 0$ to $x = 10$ in. and a concentrated load of 6 lbs placed at $x = 0$. Orient the beam to give minimum deflection. Verify the theoretical deflection equation at several locations along the beam.

The following equipment is available:

- Beam support
- Dial indicator
- Brass beam with end plug ($E = 14 \times 10^6$ psi, $I = 0.0217$ in⁴, $S = 0.0308$ in³)
- 1 - 6 lb weight
- 10 - 1 lb weights
- Ruler

Return all equipment to its assigned location after use.



Apparatus 5

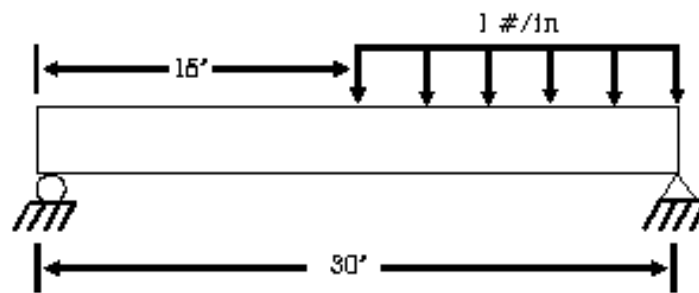
Problem 6

Using Apparatus 6 investigate the deflection of a simple beam under the action of a uniformly distributed load of 1 lb/in placed on the beam at a distance of $x = 15$ in. to $x = 30$ in. The distance between supports is 30 in. Orient the beam to produce maximum deflection. Verify the theoretical deflection equation at several locations along the beam.

The following equipment is available:

- Roller support
- Angle support
- Aluminum WF beam ($E = 9.5 \times 10^6$ psi, $I = 0.0210$ in⁴, $S = 0.042$ in³)
- Dial indicator
- Ruler
- 15 - 1 lb weights

Return all equipment to its assigned location after use.



Apparatus 6

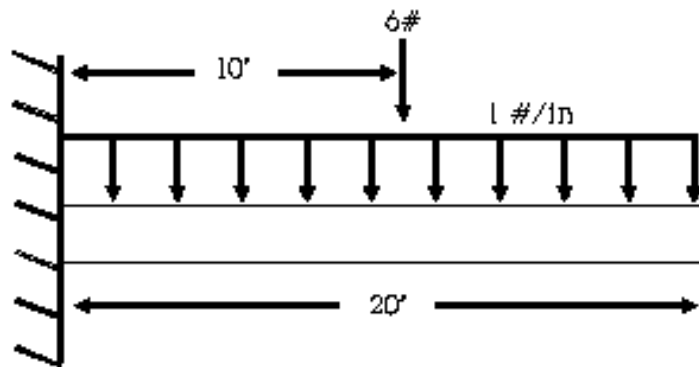
Problem 7

Using Apparatus 7 investigate the deflection of a brass cantilever beam under the action of a uniformly distributed load of 1 lb/in placed at a distance of $x = 0$ to $x = 20$ in. and a concentrated load of 6 lbs placed at $x = 10$ in. Verify the theoretical deflection equation at several sections along the beam. Orient the beam to produce minimum deflection.

The following equipment is available:

- Beam support
- Dial indicator
- Brass beam with end plug ($E = 14 \times 10^6$ psi, $I = 0.0217 \text{ in}^4$, $S = 0.0308 \text{ in}^3$)
- 1 - 6 lb weight
- 20 - 1 lb weights
- Ruler

Return all equipment to its assigned location after use.



Apparatus 7

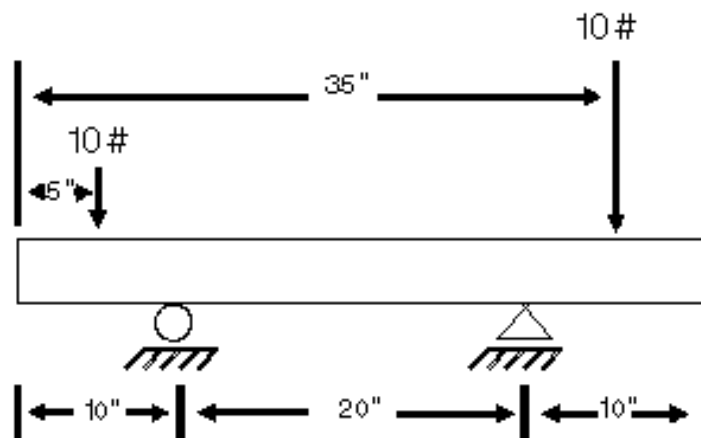
Problem 8

Using Apparatus 8 investigate the deflection of an overhanging beam with 20 in. between supports and with a 10 in. overhang on each end. The beam will be loaded with 2 - 10 lb concentrated loads, one at $x = 5$ in. and one at $x = 35$ in. Orient the beam to produce maximum deflection. Verify the theoretical deflection equation at several sections along the beam.

The following equipment is available:

- Beam support
- 1 Roller support
- 1 Angle support
- A box aluminum beam ($E = 10 \times 10^6$ psi, $I = 0.00944 \text{ in}^4$, $S = 0.03776 \text{ in}^3$)
- Dial indicator
- 2 - 10 lb weights
- Ruler

Return all equipment to its assigned location after use.



Apparatus 8